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Congestion Management Case Studies

Developing Effective Congestion Management Systems

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Data Collection and Analysis Methods to Support Congestion Management Systems

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This is one of a series of reports issued periodically by the Federal Highway Administration's Office of Environment and Planning, Metropolitan Planning Division (HEP-20), 400 Seventh Street, SW, Washington, DC 20590. The purpose of the series is to share the latest information on metropolitan planning techniques and analytical procedures. This series will include the results of in-house and contract research, papers written or presented by staff, and summaries of workshops or conferences. Comments on these reports, and recommendations for material to include are welcome.

PREFACE

This is the eighth in a periodic series of reports issued by the Metropolitan Planning Division, Federal Highway Administration. Included in this issue are two synthesis reports of recent research in the area of transportation planning, specifically with regard to congestion management. The research behind both reports was sponsored by the Metropolitan Planning Division. This document was produced and is being distributed as part of a continuing effort by FHWA's Office of Environment and Planning to provide timely and pertinent information to those involved in Metropolitan Planning related activities.

This report is intended to increase professional knowledge of those working to develop, implement, and sustain **congestion mitigation** and **mobility enhancement activities**. Examples of practice are presented which have potential application to any number of local, regional, or statewide initiatives. The reports vary in discussion from the technical and institutional, to the planning process in general. The information presented is also relevant to metropolitan planning organization (MPO) and state department of transportation (DOT) staff working with congestion management systems (CMSs) -- one of the six management systems outlined in the *Intermodal Surface Transportation Efficiency Act* (ISTEA) of 1991.

The first report "Developing Effective Congestion Management Systems" chronicles the early development and implementation experiences of four metropolitan areas: Albany, NY; Dallas / Ft. Worth, TX; Seattle, WA; and Washington, DC. Each case study is examined with respect to select technical and institutional elements of its practice.

The second report "Data Collection and Analysis Methods to Support Congestion Management Systems" was presented at a TRB conference. The paper summarizes performance measures and analytical methods. It also describes CMS-related work in three case study areas: Montana's experience using HPMS as a CMS resource; Albuquerque's GIS applications; and Boston's integration of data for multimodal improvements in the downtown.

Chosen for the variety of approaches they represent, these cases are presented as examples for practice.

More detailed reports have been prepared regarding the case studies presented here. For details on how to obtain a copy of these reports please fax your request to FHWA's Metropolitan Planning Division at (202) 366-3713. Include your name, organization, telephone, and fax number.

August, 1995

DEVELOPING EFFECTIVE CONGESTION MANAGEMENT SYSTEMS

FOUR METROPOLITAN AREA CASE STUDIES: ALBANY, NY DALLAS / FT. WORTH, TX SEATTLE / TACOMA, WA WASHINGTON, DC

Interim Summary Report

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TABLE OF CONTENTS

PROJECT BACKGROUND

This paper has been prepared by the Federal Highway Administration (FHWA), Office of Environment and Planning, for distribution to interested state department of transportation (DOT) and metropolitan planning organization (MPO) staff --especially those responsible for the implementation of congestion management systems (CMSs). The CMS is one of six transportation management systems outlined by the *Intermodal Surface Transportation Efficiency Act* (ISTEA) of 1991.

The research for this report began in October 1994 following requests for further guidance on congestion mitigation initiatives, and CMS development and implementation strategies. This interim summary report represents the analysis of a six month effort of four MPOs chosen to participate as case studies.

The four MPOs each prepared a more detailed interim report; for details on obtaining a copy of these reports please fax your request to FHWA's Planning Support Branch at ***(202) 366-3713.*** *Include your name, organization, telephone, and fax number.*

The final report is planned for distribution late in 1995, and will include updates since the writing of this document, additional experiences working with CMS implementation, and other useful details.

The Case Studies

Four case study areas were selected for the variety their geographic characteristics, demographics, growth patterns, and air quality designations represent. **These cases are not presented as perfect models, but rather, as examples for practice.** It is intended that readers will benefit from the information presented and find some applicability to their own state or region. For example, air quality non-attainment areas ranging from moderate to serious are included. In addition, regions with varying degrees of attention placed on multimodal performance are presented. **Table 1** highlights characteristics of the four case study sites selected for this effort.

The reader should note that this report is based on selected elements of the CMS work that the four case areas are doing. Rather than discussing the entirety of each area's CMS work plan and implementation efforts, *specific* focus areas have been assigned for each. A list of these focus areas follows in **Table 2.**

The reader will find that **technical** and **institutional** aspects of congestion management initiatives are discussed. Moreover, the discussions show how a few of the areas consider the CMS to be fully integrated within their entire **planning process**, and to have yielded substantial gains for transportation in their region.

The information in Tables 1 and 2 is intended to be useful to areas interested in finding techniques which may be transferrable.

TABLE 1: Air Quality Status, Demographics and Transportation Statistics

CASE STUDY AREA	Albany, NY	Dallas / Ft. Worth, TX	Seattle/Tacoma, WA	Metropolitan Washington
AIR QUALITY STATUS[1]				
Ozone	Marginal	Moderate	Marginal	Serious
Carbon Monoxide	In attainment	In attainment	Moderate	Moderate
MPO PLANNING AREA DEMOGRAPHICS[2]				
Urban Land Area	365 sq. miles	4,962 sq. miles	6,300 sq. miles	3,021 sq. miles
Population	.76 million ('93)	3.8 million ('90)	2.7 million ('90)	3.7 million ('90)
Projection	*.83 million (2015)*	*5.0 million (2010)*	*4.1 million (2020)*	*5.1 million (2020)*
Type of Development	4 central cities	50 local governments	60 municipalities	3 major jurisdictions (MD, VA, DC) and 16 local gov'ts.
TRANSPORTATION STATISTICS[2]				
Highway Network	136 freeway miles	570 freeway miles	330 freeway miles	374 freeway miles
Transit Network	Bus only	Bus, Rail (light & commuter)	Bus only, Auto and passenger-only ferries	Bus, Rail (commuter and rapid transit)

[1]Source: Environmental Protection Agency. *Ozone and Carbon Monoxide Areas Designated Non-Attainment*. October 26, 1991.

[2]Sources for these figures are, respectively: CDTC, NCTCOG, PSRC, and MWCOG.

Table 2: Local and State Agencies, Focus Areas, and CMS Implementation Dates

CASE STUDY AREA	*Albany, NY*	*Dallas / Ft. Worth, TX*	*Seattle / Tacoma, WA*	*Metropolitan Washington*
STATE AGENCY	New York State DOT	Texas DOT	Washington state DOT	District of Columbia Dept. of Public Works
LOCAL AGENCY	Capital District Transportation Committee (CDTC)	North Central Texas Council of Governments (NCTCOG)	Puget Sound Regional Council (PSRC)	National Capital Region Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (MWCOG)
CASE STUDY ORIENTATION	policy, programming	policy, programming	policy, technical, programming	policy, technical
FOCUS AREA	1. CMS integration into planning & programming 2. Multimodal activities enhanced by CMS 3. Public Participation	1. *Non-traditional* participants in decision making 2. Distributing CMS info. to decision makers 3. Decision-making	1. ITS support for data monitoring requmn't.s 2. Integrating CMS efforts with planning & programming	1. Regional transportation data management 2. Performance measures development & testing

Introduction to Case Areas

Several common themes have been identified among the four cases followed here during their development of CMSs. Each area has tried to provide or strengthen the link between technical and policy bodies. Several have also used task forces and technical support committees as mechanisms to allow for public input -- thus strengthening the regional long range plan and transportation improvement program (TIP).

CMS activities for the **Albany-Schenectady-Troy region** have been integrated with the CDTC long-range effort, entitled *'New Visions'*. An important part of New Visions outreach has been the establishment of nine task forces. These task forces capture the subjects of the management systems, and clearly go beyond the letter of the management systems into the broad range of subjects cited under the ISTEA metropolitan planning regulations. Generally, task force membership includes committed business leaders, environmental advocates, freight operators and users, state and local government leaders, interested residents and other stakeholders. The task forces address a number of issues and are named for their area of focus:

-- Arterial Management -- Demographics & Growth Futures

- -- Expressway Management
- -- Goods Movement
- -- Incident Management
- -- Pedestrian & Bicycle
- -- Transit Futures
- -- Land Use
- -- Urban Issues

All CDTC's efforts are focused on the development of a CMS which more fully feeds the TIP and other longer range planning processes.

In the **Dallas-Fort Worth region**, the North Central Texas Council of Governments (NCTCOG) acts as the initiator and facilitator of dialogue for the purpose of achieving "workable" long term goals. NCTCOG also acts as a data clearinghouse for the region. This area was historically known as a pro-highway, limited transit territory. However, as population density increases and more growth is expected for the region, efforts to provide for a variety of affordable transit options to supplement highway travel have been on the rise. By the end of 1996, the region will have a fully operational 20 mile light rail and 34 mile commuter rail service. Both facilities are presently under construction.

Such new developments have been credited to the effective incorporation of congestion management and CMS activities into transportation planning and programming, and to dialogue created while meeting ISTEA's goals. In essence, NCTCOG is involved in a breakthrough in which the paradigm that resists long term planning and regional thinking is being altered.

Puget Sound Regional Council (PSRC), the MPO for the **Seattle-Tacoma metropolitan area,** has been investigating the potential of intelligent transportation system (ITS) technology to simultaneously support local operations, the region's long range plan, and CMS performance monitoring requirements. Essentially, transportation system performance data, collected using ITS technologies, will be delivered through an information pipeline (Internet) by various sources, and then accessed on an on-going basis for the development of reports to support decision making, or as an information provider to state and local governments. The data will also be used to derive a travel time performance by mode (i.e. SOV, HOV, transit, ferry, freight and nonmotorized), as well as other transportation performance information.

Similar to the MPO in the other case areas, PSRC acts as a coordinator of activities. The MPO developed the region's growth and transportation strategy, *'VISION 2020',* as a framework for managing future growth and identifying appropriate transportation strategies to be included in its metropolitan transportation plan. The CMS is designed to help PSRC and the localities assess their progress in achieving federal, state, and local policy aims.

For the **metropolitan Washington area**, coordination of CMS activities for parts of Maryland and Virginia and the entirety of the District of Columbia has proven to be challenging. A regional CMS had to be consistent with not one but three statewide management system designs (for the District of Columbia, the state of Maryland, and the state of Virginia), as well as meeting the needs of a number of local governments and agencies from around the region.

The CMS Task Force, a subcommittee of the MPO's Technical Committee, was created to study and respond to the federal management systems requirements, and provide recommendations on how to address these requirements. It was comprised of members from the Maryland and Virginia state DOTs, the District of Columbia Department of Public Works, transit agencies, and staff members from local governments around the region. Among the achievements of the CMS Task Force was the selection of some two dozen measures for use in assessing performance of the region's extensive, multimodal surface transportation system.

FOCUS AREAS AND FINDINGS

Albany, New York

Focus Area 1: Innovative applications for CMS in making planning and programming decisions

Attention in this effort focuses on how CDTC approaches integrating CMS decisions into the planning and programming process, as well as what impact these approaches may have on the process.

<u>Visioning</u>

As part of the visioning process, CDTC developed Congestion Management and Planning and Investment Principles. The principles call for consideration of demand management, cost effective operational actions, incident management, land use management and corridor protection. Together, they inform CDTC's decision process, helping to determine which multimodal activities will be investigated and which persons and organizations should be encouraged to participate in the planning process.

<u>Ensuring Performance</u>

CDTC's perspective is that the management systems are the most logical location for data collection and basic interpretation of system performance. As a result, CDTC's CMS describes principles, *visioning*, priority setting and scoping processes as well as data collection and analysis. Integration of the CMS into planning and programming has been based on the development of core system performance measures, falling into three main categories: transportation service, resource requirements and external effects. Together these cover the quantitative and qualitative costs involved in transportation systems, and allow the MPO to ensure that congestion needs are adequately considered in the decision making process.

CDTC's approach to integration of the CMS into transportation planning and programming has resulted many positive impacts. Some benefits associated with the CMS include those listed below:

- information supporting **TIP** project selection and *'New Visions'* **long range plan** development
- identification of **travel demand management**'s (TDM) regional importance
- ability to **program TDM initiatives** in the TIP
- encouragement of **arterial management**
- closer **link between design and planning** processes
- ability to support other **demand management programs** (e.g. commuter register, and new transit initiatives)
- ability to make **tradeoffs between different objectives** (e.g. trade off analysis must compare incremental cost with current critical capacity needs for such projects as Interstate bridge replacements)
- ability to program projects in the TIP requiring significant **private funding** through development mitigation fees or transportation development district fees
- high prioritization of **transit, bicycle, pedestrian components** to urban highway improvement projects
- high prioritization of projects fostering **intermodal connections**

Focus Area 2: Enhance multimodal activities through CMS

Attention centers on how consideration of transit, pedestrian and bicycle planning needs are integrated into priority setting, and how these needs can be addressed through CMS.

Based on the principles developed by the Transit Futures Task Force and other task forces, CDTC aims to offer an alternative travel mode to reduce dependence on the auto and provide essential mobility for those not operating a private vehicle. Furthermore, CDTC also aims to support regional and local land use policies. Key to CDTC's success in achieving its goals is the consistent measurement, irrespective of mode, of a strategy's merit and effectiveness. The region's CMS was developed as a tool in this vein, to enhance multimodal objectives and increase the rate at which such objectives are implemented as projects.

At the project level, multimodal consideration is broadened to include bicycle, pedestrian and transit service opportunities, design considerations, and freight requirements. At the sub-regional level, the programming decision is based upon factors such as system consistency and land use plans, provision of alternative modes, and inputs from public participation. One outgrowth of CDTC's public involvement process, for example, has been an identified need to improve the connectivity of neighborhoods and communities through serious investments in *'walkability'*.

A parallel effort exists in the Bicycle And Pedestrian Task Force's method for incorporating more multimodal designs into TIP projects. The task force drafted methodology to argue for the inclusion of bicycle and pedestrian treatments as TIP expenditures are made. Following standards set forth in FHWA's manual Selecting Roadway Design Treatments to Accommodate Bicycles[3], CDTC is addressing needs both **facility-based** (bike path and walkway) and **accessibility-based** (safe access/egress points, surface drainage and maintenance, safe interaction between modes and away from motorists). In addition, the region has also targeted 1,000 miles of highway desirable for bicycle use and a 350 mile priority bicycle network for long range activities designed to enhance the transportation system.

Focus Area 3: Document the public participation process

This effort focuses on how CMS activities have led to more rigor in the priority setting process, in particular, those areas where public involvement occurs. It also documents the nature of the involvement as well as the impact it has on the process.

A public outreach program has been developed for CDTC New Visions which is essential in progressing the CMS. According to CDTC, their public involvement efforts have paid substantial dividends for the region -- some of which were not foreseen. Listed below are some of the more noteworthy practices which have developed in CDTC's public participation arena.

The **design of a public involvement program** that used a mail-back survey and two public scoping meetings. Following the survey, agency staff brain stormed to identify over 500 stakeholders who could be involved in some way.

Public input encouraged through both formal and informal settings -- as opposed to restricting involvement to more general, "one-size-fits-all" type meetings.

Public education to develop in the community a general understanding of transportation planning processes and issues. CDTC developed *"A Guide to Advancing Transportation Projects in the Capital District"* -- an educational 10-page document, written in simple language.

Open TIP process to ensure adequate local support and demonstrated public involvement r.e. project selection. In addition to opinions gathered through the

[3] FHWA suggested using **bicycle treatment** standards, area character and motor vehicle traffic volumes in the preparation of the bicycle and pedestrian features. **Pedestrian Treatments** are not based on any established standards but rather on traffic volume area type and other variables influencing actual/potential pedestrian traffic in the vicinity of the project. Refer to the *References* for a more comprehensive description of this manual.

outreach program, special effort is made to reach populations not usually involved, but nevertheless impacted by TIP actions.

Expressway Management Task Force members (such as the State Police and the Thruway Authority) have enthusiastically pursued incident management initiatives. This task force has asked CDTC to facilitate the incident management dialogue needed among member agencies and the local police and fire departments, as well as emergency medical service providers. Other task forces have discovered opportunities for congestion management initiatives because of the participation of members who were not previously given such a forum.

The **performance measure development** process yielded a *"community quality of life" (CQOL)* measure. Developed by the Urban Issues task force, the CQOL measure is a testament to CDTC's commitment to public involvement, as the measure attempts to capture how transportation interacts with land use, and influences "quality of life" at the community level. It is a core performance measure in the Regional Transportation Plan that cuts across issue areas and is at the heart of *'New Visions'* goals. *CQOL* has increased the visibility of issues such as:

- increasing pedestrian activity for recreation;
- handling the disproportionate rise of transportation costs; and
- removing barriers caused by accommodating autos (wide streets, lack of pedestrian, bicycle and transit facilities).

Dallas / Ft. Worth, Texas

Focus Area 1: Develop a list of participants and criteria for their involvement

Of interest here are the local governments and non-traditional decision makers involved. Particular attention is paid to criteria used for their involvement, their role in the CMS and planning and programming, and their impacts on the process.

<u>The Participants</u>

NCTCOG has adopted a policy for participation that includes fostering involvement from all aspects of the community. A structure is used where the formal policy board is supported by a series of committees and working groups. The structure brings both traditional and non-traditional players together for CMS activities, which are undertaken in support of the larger goals of plan and program development. Drawing input from many in the region, NCTCOG simultaneously addresses regulatory and technical issues while planning for the region's 16 counties. To follow are some noteworthy points regarding the players at NCTCOG.

The **policy board** consists of locally elected officials and representatives from area transportation authorities -- Texas Turnpike and Texas DOT District Engineers.

Four technical committees support the policy board by providing input and technical review for the planning process. These committees are made up of personnel from city and county, public works, transit operator, engineering and planning departments. Some public/private partnerships are also used within the technical committee structure, taking advantage of the contributions to be had from management-level professionals. These committees have worked extensively on the development of CMS strategies and integration of CMS with the region's long range plan.

Several subcommittees, working groups and task forces are also included in the region's transportation planning dialogue. Subcommittees of the policy board examine policy positions and prioritize CMS and other initiatives. Working groups center around specific planning or programming activities. For example,

-- a ***CMS working group*** provided assistance to staff in the development of performance measures, and helped to explore issues to address BEFORE they reached the full technical and review bodies; and
-- ***traffic and incident management teams*** draw on experience from committee members and other non-traditional players such as law enforcement, hazardous material handlers, emergency response personnel (i.e. fire, ambulatory, police), etc., in order to identify low-cost congestion reducing strategies.

Criteria for Involvement

Overall, NCTCOG uses as its primary criteria for involvement in its committees the degree to which persons are likely to contribute to a group's objectives (see **Figure 1**). For example, emergency response personnel are critical to developing incident management strategies where non-recurring congestion is concerned, and thus play important roles on the incident management committee. As a rule, NCTCOG has found that the more technical the issues to be faced by a particular group, the more reliance is placed on engineers and technical experts. Similarly, politically charged or legal issues are handled by committee members representing local government and business interests.

The synergy created in involving such diverse participants has yielded a valuable degree of consensus on congestion management strategies. By involving the public, local governments and business representatives -- NCTCOG has come against limited resistance

Figure 1: NCTCOG Involvement Plan

Who	Why	Results
City/ council gov't	political interests	The level of involvement of the participants has depended on the issue at hand.
engineers, transit authority	technical interests	
chamber of commerce, private companies	commercial (economic growth of region)	The impact of NCTCOG's involvement plan has been: consensus on strategies, less resistance to change, and synergistic benefits to the efforts involved.
general public	broad interest of private citizens	
emergency response personnel	expertise/ high stakes	

to change and is achieving agreement on regional transportation goals. An added benefit of NCTCOG's wide-ranging involvement process is an increased public awareness of the air quality and traffic implications to personal mobility choices; moreover, NCTCOG is finding the region feels involved in decision making.

Focus Area 2: Dissemination of CMS information to professionals and the public

Information dissemination activities and the use of public involvement in that process are the focus here. The documentation includes how the MPO engages in communication with local government officials and other involved parties, as well as the nature of that communication.

NCTCOG has adopted a proactive process for making the public aware of transportation plans and programs, and for soliciting input from those wishing to participate. In addition to public meetings and printed media, NCTCOG includes several innovative approaches for increasing public awareness of regional traffic congestion and air quality issues, and harnessing community opinions on the issues and possible solutions.

For **committee meetings** -- notices, agendas, and action items are mailed out to members and also transmitted to major news media. Council attendance is confirmed through phone calls. All meetings are "open". The objective is to raise the visibility of the committees and reach invitees through *at least one* notification method.

A regional, ASCII-based dial-up system and access to a World Wide Web Page have been implemented to give computer access to NCTCOG's information and communication services. The initial **information system** allows access to: TIP project tracking; monthly calendar and progress reports; bulletins, news and publications; and committee mailings, rosters and minutes. Future plans for making the system more interactive and accessible are under development.

NCTCOG also has outreach efforts **specifically targeted at businesses** (e.g. a task force to develop their support for transportation), **local governments** (e.g. training seminars on congestion management techniques) and the **public at-large** (e.g. air quality videos).

Additional NCTCOG dissemination activities include:

- -- regular **public meetings**
- -- mail-back **input surveys**
- -- **open committee** meetings
- -- public/private **partnerships**
- -- traffic management **forum**
- -- NCTCOG **Public Affairs Dept.** outreach
- -- professional and public **newsletters**
- -- **monthly reports** r.e. project progress and events
- -- public and private sector **training**
- -- incident management **video**

Focus Area 3: The decision making process

This area focuses on documenting the integration of the CMS into decision-making processes. It also focuses on the impact the various participants have.

To implement a CMS which is fully integrated into transportation decision making in the Dallas / Ft. Worth region -- NCTCOG has identified five of its functions where the CMS will be directly linked to regional planning and programming activities:

1. Development and maintenance of the **regional transportation plan** (RTP)
2. Development and implementation of the **TIP**
3. Participation in **major investment and corridor studies**
4. Conducting transportation-related air quality planning to support the **state implementation plan** (SIP)
5. Providing **support to member** governments, related agencies and the public.

In fulfilling its responsibilities with regard to each of these functions, NCTCOG intends, in its own words, "to incorporate a 'congestion management philosophy' into all aspects of planning and programming." Thus, the CMS is being used as a dynamic decision-making tool -- making an initial assessment of congestion, identifying congested facilities, and subsequently developing regional strategies and targeting resources for use in their implementation.

Over time, the CMS is also expected to supply inofmation on the effectiveness of implemented strategies, and house an ongoing program of monitoring regional congestion at area, system, and facility levels of detail. The intent is tor inform decisions and leverage resources spent to achieve mobility and efficiency in the transportation system.

A "State of the Region" report is planned, for example. This document will annually report on regional traffic congestion prior to updates of the RTP in order to support plan development. NCTCOG's policy board, the Texas DOT district offices, local transportation authorities, and local governments will be the report's audience.

Additionally, NCTCOG is working with CMS related activities to:

-- enhance, strengthen, and support TIP decisions by developing **project selection criteria** that promote cost-effective congestion mitigation strategies;
-- ensure strategies included in the TIP undergo **timely implementation**;
-- incorporate effective CMS strategies into **MIS corridors** and the region's **air quality program**;
-- provide **information to the other management systems** on traffic congestion and trends;
-- calibrate **travel models** using CMS information on speeds, travel times, and location and effects of non-recurring congestion; and
-- provide **information to local governments and agencies** regarding state-of-the-practice strategies for mitigating congestion.

Seattle / Tacoma, Washington

Focus Area 1: Investigate the potential of ITS to support CMS data monitoring requirements

The focus here is the development of technical and institutional mechanisms for using ITS-based travel time data to meet the monitoring needs of a multimodal CMS, oriented to both passenger and goods movement.

Using Travel Time

Travel time information allows one the flexibility to compare performance of single occupant vehicles (SOVs), transit, vanpools, carpools, goods movement, and potentially, bicycles. Recognizing the value of such flexibility, the Central Puget Sound region selected travel time performance as its primary measure for CMS data monitoring purposes.

The region early on assessed that the expense of collecting travel time information for CMS would be difficult to justify unless included as part of existing efforts. Thus, in the interest of keeping costs down and creating a viable performance monitoring plan, PSRC made several decisions:

-- to initially **focus efforts** regarding extensive data collection on the facilities identified in the CMS work plan;
-- to achieve travel monitoring goals by "**piggy backing**" on advanced data collection activities already being implemented; and
-- to **stage a transition** over the next few years from the volume-to-capacity measure in use to a travel time measure, as plans for advanced data collection move to implementation.

Providing Data Linkages

PSRC sees adopting a travel time measure for performance as an important opportunity to develop linkages to new data collection systems in the region, including:

-- the North Seattle **Advanced Traffic Monitoring System** (ATMS),
-- the **loop detection** system run by Washington state DOT (WSDOT),
-- Metro and Community Transit's Traffic **Signal Priority** Project,
-- the Metro Transit and University of Washington **automatic vehicle location systems** (AVLs),
-- and other locally based systems.

A key factor in establishing linkages among these systems is expected to be the success of the ***ITS Backbone Project***, co-sponsored by PSRC and WSDOT. The Backbone project is designed to create a common pipeline over the Internet for advanced data collection systems, allowing the region to eavesdrop on travel data and use it to inform decisions.

The Backbone gathers travel times for automobile, freight and transit traffic in a dynamic exercise involving many agencies and extensive use of the region's ITS data collection activities. For example, by interfacing with an existing AVL system owned and operated by Seattle Metro, real time transit vehicle locations can be obtained. Freeway congestion information is also obtained by interfacing with the existing loop detection system owned and operated by WSDOT. Then using system components such as *data acquisition control systems, GIS command and control consoles, display systems and communication ports* -- the data from the AVL and loop sources are fused, yielding detailed information in the Backbone about the region's transportation system and travel conditions.

Though the data collection process is complicated, from the perspective of the Backbone users, each system connected to it actually represents a single data source. The Backbone actually makes accessing information from multiple sources a manageable exercise. Furthermore, with the Internet connection provided, agencies can access the data remotely, yet impact neither the data's integrity nor the source agency's use of it.

Institutional Issues

The cost of making data available through the ITS Backbone and Internet connection is minimal to agencies in the Puget Sound; yet the benefits are considerable. The effort recognizes that independent agencies are often unwilling to share data for joint development if it means they must adjust current procedures or sacrifice the security and integrity surrounding their data. Thus, this project addresses such issues head on. The ITS Backbone encourages regional cooperation of transportation agencies as each recognizes the benefits it gains by participating. The project makes information available without impacting the operations, philosophies, or integrity of agencies' objectives in gathering the data. The agencies have an opportunity to access and benefit from information from a variety of sources, "despite the fact that they are geographically separate, philosophically distinct, and highly conscious of data integrity"[4].

Despite the potential for success, several issues have been identified in the region which need to be addressed as the ITS Backbone project and other ITS data collection activities move to full implementation. Some of the collection systems used are proprietary in nature, a fact which can complicate the design and development of information sharing techniques, as well as make it difficult to fine tune the data collected. Additionally, real time validations and processes for ensuring system maintenance must be addressed if real time information is to be openly broadcast to transportation agencies.

Focus Area 2: Develop procedures for combining congestion management projects with the transportation planning and programming processes

The focus here is on demonstrating how a CMS will be effectively integrated into transportation planning and programming. Attention is given to using performance measures as criteria for decisions and as a means for informing interested parties.

In addition to requirements that the CMS be consistent with federal law, the Washington state Growth Management Act requires that PSRC base regional plans on local comprehensive plans and policies. Thus, PSRC needed to design a CMS that would satisfy these many requirements simultaneously, as well as establish a mechanism to support effective planning and programming decisions. In this vein, the CMS was given a strong link to the region's long range strategy for growth and transportation, VISION 2020. PSRC anticipates that using travel time as a foundation for explaining the benefits and trade-offs gained with particular projects and plans will enable citizens and public officials to better understand transportation system deficiencies and make more effective investment decisions.

[4] D.J. Dailey and M.P. Haselkorn. *Demonstration of an Advanced Public Transportation System in the Context of an IVHS Regional Architecture.* Presented at the First World Congress: Paris, France. December 1994.

Table 3: PSRC Project Selection Process

Summary of First Stage Screening Criteria	*Summary of Second Stage Technical Evaluation Criteria*
improve mobility	maintain & preserve system
economic vitality	manage congestion across modes
	improve mobility & travel times
improve system performance	reduce safety & security problems
reduce reliance on SOVs	improve efficiency & modal reliability
	improve accessibility & modal connectivity
improve accessibility & modal connectivity	promote mobility & economic vitality
improve air quality	improve air quality and save energy
	generates other environmental benefits
	cost effectiveness, using project score

Project Selection

PSRC's primary CMS goals are to provide staff, policy officials, and the public with information relevant to how the transportation system is operating, and to help identify cost-effective strategies to achieve performance goals. As evidenced by **Table 3**'s criteria for project screening and evaluation, PSRC's project selection process incorporates significant congestion mitigation themes. Moreover, CMS activities are intended to support the selection process and the region's transportation plans, by translating system information into terms useful for choosing among such projects as travel demand and system management strategies, system preservation and capacity expansion projects.

For example, PSRC notes that **travel time data** could be used to identify congested areas where a new transit signal priority system might allow transit vehicles to move more quickly through a corridor. In this case, transit's travel time savings in the corridor could induce mode shift from SOV to transit, and thereby circumvent the need to implement a road widening project.

In order to further supplement the flexibility offered by a travel time measure, the region has selected a number of other indicators of system performance. Traffic **volumes, lane occupancy rates, and vehicle speed** will be used to add to decision makers understanding of how the many modes of the system are operating. In addition, **schedule reliability and safety data** have been targeted to help measure and track the performance of freight and goods movement in the area.

Metropolitan Washington

Focus Area 1: Developing and expanding management of regional transportation data

Of interest here is how data can be formatted, developed, and implemented to best meet CMS and regional planning activities. MWCOG's work with data integration is also of interest.

Metropolitan Washington D.C. had a regional monitoring program in place prior to ISTEA requirements for such. Thus, while other regions were developing a new monitoring program, MWCOG was able to take advantage of its "leg up" and use ISTEA as an opportunity to further enhance its efforts at establishing a Regional Transportation Data Clearinghouse. The clearinghouse was originally intended as a means of supporting transportation decisions in the region, a theme echoed by the CMS requirement in ISTEA.

Regional Transportation Data Clearinghouse

The COG/TPB determined that the clearinghouse needed to consider both the utility of the data and how the data could be integrated into regional information systems. The CMS was made a driving force in developing the clearinghouse as a master data set, which could support a variety of planning activities for the region, including travel forecasting and air quality analysis.

MWCOG and its members decided to use the following data types as basic building blocks for its data clearinghouse and CMS monitoring activities:

- traffic volumes
- traffic density
- traffic speeds
- vehicle classifications

- -- vehicle occupancy
- -- transit ridership
- -- facility capacity

The source agency varies for each data type included above. COG/TPB typically collects traffic speeds and vehicle occupancy data. State and local agencies generally collect traffic volumes, vehicle classifications, and transit ridership information -- though COG/TPB does sometimes collect this data, as well.

In support of the clearinghouse, additional information has been assembled, such as: political boundaries, signalized intersection and variable message sign locations, and the status of National Highway System facilities. Moreover, the MPO has recently collected information on traffic density for freeways in the region, and has embarked on an extensive program monitoring speed and travel time data.

Travel Monitoring Program

The region's monitoring program is designed primarily to supplement the data already collected and available to MWCOG and its members. Key components of the program are included below.

Aerial Surveys are used to monitor traffic density on limited-access highways. A relatively inexpensive[5] and comprehensive way to gauge performance of a freeway system operated by different agencies, the survey photographs are also available for later analyses.

Accident data will be collected as available on the freeway system and used to develop a regional database to gauge impacts of accidents on congestion over time.

Speed, travel time and delay will be used as primary indicators of regional and corridor-based congestion. An arterial speeds model will gauge travel time and congestion on the region's arterial highways.

Cordon counts are being taken as part of an effort ongoing since the 1960's, in order to assess the impact of constructing the region's Metrorail system. The counts are also used to calibrate the regional travel demand forecasting model. Three cordon count programs performed on a three-year cycle also help with trend analysis.

Home interviews and external surveys were conducted in 1994, to help upgrade regional travel models.

[5]The cost of the peak hour study performed in FY '93 was $70,000 for all data collection and analysis.

Freight and goods movement research is being continued by the CMS Task Force. Of particular interest are delivery trucks with frequent stops in urban areas, and freight generation at airports.

Visitor and tourist travel are being investigated in terms of their relationship to congestion. Such travel is a significant component of the metropolitan Washington transportation system. Taxi movement is a related issue under study.

Lessons Learned and Future Plans

It is anticipated that the clearinghouse will create an opportunity for comparison of regional planning activities and their products (e.g. the CMS, regional travel forecasting, model upgrades, etc.). Moreover, the clearinghouse provides a forum for MWCOG and its member agencies to examine data availability and practice, and to assess the need and possibility for improvements.

In its early experiences, COG/TPB found some difficulties in working with the clearinghouse and the large volumes of data available in the region. For example,

-- agencies had **less complete data** on hand than was hoped, given budget cutbacks, etc.;
-- certain data **retrieval processes were not as functional** as initially believed, as in the case of automatic traffic recorders (ATRs);
-- furnishing data sometimes met with **data sensitivity or formatting barriers**; and
-- displaying and presenting the data, maintaining "truth-in-data", and creating compatibility are **substantial issues** that need further address.

Future activities identified for the clearinghouse include:

-- working to **overcome several issues** and problems encountered to date;
-- cyclically conducting **additional aerial surveys** over time;
-- cyclically obtaining **cordon counts** (with one bicycle-oriented effort planned);
-- studying **vehicle occupancies** r.e. changing facilities from *HOV-3* (three persons per vehicle minimum) to *HOV-2* (two persons per vehicle minimum); and
-- establishing the Regional Transportation Data Clearinghouse on a **geographic information system for transportation** (GIS-T) . GIS-T activities include:
    -- formatting and transferring data into the GIS's relational database system;
    -- creating a base network on the GIS, defined using Census TIGER files and existing model networks on the regional travel demand model; and
    -- defining data needs, formats, and access arrangements in cooperation with local agencies.

Focus Area 2: Establishing and testing regional performance measures

Of special interest here are performance measures applicable at the regional or subarea level, as opposed to intersection or corridor levels. Also of interest are measures for evaluating multiple modes and congestion management strategies.

The range of performance measures a region can adopt is a direct function of the data available to support the measures. In the metropolitan Washington area, travel monitoring has historically been based on such information as traffic volumes, vehicle classification, vehicle occupancy, transit ridership reports, and speed. Used for both project analysis and demand models in the region, this range of data has been at the core of the area's performance monitoring for years. Additionally, occasional efforts have been geared towards collecting information suitable for multimodal comparisons.

Defining performance measures

A series of discussions were held by the CMS task force regarding what type of performance measures to adopt for the region. These included discussions of how best to achieve a performance indicator for use in travel forecasting, system evaluation, and comparing investment alternatives. Also, the task force noted that measures sensitive to the multimodal, wide-area type of planning ISTEA intended would need to be adopted. In this regard, the benefits and drawbacks of two major indicators were discussed: a delay-based measure, or a level-of-service (LOS) type measure.

A **delay** measure would require designation of an "optimum" travel time or speed (free-flow conditions) as a baseline for comparison. In setting such an optimum, one would also have to determine whether free-flow includes stopping at traffic signals, posted speeds, etc. **Level-of-service (LOS)** measures have been used frequently in the past, and seemed a good alternative to using delay. Furthermore, a level of understanding and buy-in exists for LOS from regional decision makers and the public. LOS drawbacks include its limited sensitivity to multimodalism. Moreover, a method would need to be created for distinguishing among the many locations in the region which today operate at varying servereties of LOS F.

The task force adopted a solution whereby a whole series of measures would be developed -- in order that the most appropriate measure could be used for a given application. A partial listing of the measures chosen for the initial CMS cycle can be found in **Table 4**. Additional discussions then focused on how to stratify the measures, and use them to most effectively identify the nature of congestion problems and the potential of specific mitigation strategies. In this regard, the CMS Task Force suggested different levels or "tiers" of analysis as most appropriate when applying the measures for CMS purposes; from largest in scope to smallest, the tiers are:
-- region wide -- corridor, and -- activity center (or "spot"specific.

Table 4: MWCOG Performance Measures

TYPE	PERFORMANCE MEASURE/INDICATOR
Data for direct assessment of current (or future background) conditions	1. traffic volumes 2. facility capacity 3. speed 4. vehicle density 5. vehicle classification 6. vehicle occupancy 7. transit ridership
Products of manipulations of other data or of computer models	8. volume-to-capacity ratio 9. level of service 10. person miles of travel/vehicle miles of travel 11. travel time by mode 12. person hours of travel/vehicle hours of travel 13. truck hours of travel 14. person hours of delay/vehicle hours of delay 15. modal shares 16. safety considerations 17. vehicle trips 18. emissions reduction benefits
Require further research before use in the CMS	19. bicycle usage and pedestrian counts 20. number of congested intersections 21. hours per day of congestion; 22. percent person miles of travel by congestion level 23. percent delay 24. number and average duration of incidents 25. truck and freight movement involvement with congestion 26. percent of person miles of travel by transit load factor 27. person volume-to-person capacity ratio

Upcoming Activities

The CMS Task Force will continue working with its performance measure plan and available data to develop a picture of congestion in the region. In addition, other efforts at COG/TPB in the next year will focus on:

-- identifying **CMS *priority* corridors** and how best to study them, given several impending projects and high profile issues;

-- creating an **inventory of analytical techniques** available for use in the CMS, perhaps as a critique of where techniques improvements could be made or how performance measures could be better designed; and

-- producing a **CMS Annual Report** for incorporation into the region's TIP and long range plan, as well as for the District of Columbia, Maryland and Virginia to incorporate into their statewide CMSs.

<u>*Lessons learned*</u>

Several lessons can be drawn from the early CMS development and implementation experiences of MWCOG and its member agencies.

1. **Take a strategic approach**
   - -- *Prioritize* all CMS activities, including travel monitoring.
   - -- Define in conjunction with member agencies what particular facilities or geographic areas are to be studied, then request from the region's transportation agencies *only data particular to those areas or facilities.*
   - -- Prioritize the *types and locations of data collection* activities, and assess which the MPO itself might have to undertake.

   Note that it was important to include as priorities locations most important in the eyes of the public and locally elected officials.
2. **Maximize use of existing data sources**
   - -- Use *existing data collection* as effectively as possible.
   - -- Develop a *thorough and on-going understanding* of member agencies' data and collection activities.
3. **Gain buy-in from participants**
   - -- Use *planning meetings* to gain buy-in from participants (such as the state transportation agency) on collecting and providing data expressly for or compatible with the regional planning process.
   - -- *Criteria for data collection locations* should be based on where member agencies want to collect data, or on designated Highway Performance Monitoring System locations.
   - -- Seek buy-in from *member agencies' planners or engineers,* and use their interest in the effort to improve its effectiveness.
4. **Keep performance measures/indicators simple and understandable**
   - -- Keep *tried-and-true* mode-specific indicators such as volume-to-capacity ratio and transit peak load factors.
   - -- *Add measures* and indicators that may begin to address intermodalism, such as delay and person hours of travel.
   - -- *Relate measures* to those used in other segments of the regional planning process, particularly travel forecasting and air quality conformity determination.

DATA COLLECTION AND ANALYSIS METHODS TO SUPPORT CONGESTION MANAGEMENT SYSTEMS

William L. Schwartz, John H. Suhrbier, and Brian J. Gardner

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DATA COLLECTION AND ANALYSIS METHODS TO SUPPORT CONGESTION MANAGEMENT SYSTEMS

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Abstract

This paper provides guidance regarding sources of transportation data and analytical methods to support the development of Congestion Management Systems (CMS). Included are measures that describe the movement of people and goods or relate to appropriate congestion measures. Alternative data sources are described along with the range of available analytical procedures and evaluation techniques. Three case studies demonstrating the use of transportation data in a CMS are discussed. These include the use of the Highway Performance Monitoring System (HPMS) in Montana, the integration of transportation data into a geographic information system (GIS) for Albuquerque, and the multiple transportation data sources used to analyze mobility in Downtown Boston.

Introduction

As required by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), states and metropolitan planning organizations (MPOs) are currently developing and implementing CMSs. Because of the flexibility provided in determining measures of system performance, the transportation data and methods that are being incorporated into these systems are quite variable. In many instances, available transportation system data are limited to traffic and roadway system data compiled for the Traffic Monitoring System for Highways (TMS/H), the HPMS, and system reporting data required by the Federal Transit Administration (Section 15).

This paper summarizes the results of a year-long research project conducted for the Metropolitan Planning Division of the Federal Highway Administration (FHWA), entitled, "Analytical Procedures to Support a Congestion Management System.": The project was undertaken in order to document understandable methods for monitoring and analyzing the impacts of congestion management strategies. The results of the study are intended to provide support to transportation agencies in responding to federal requirements for CMS. A CMS is defined as a continuous program of data collection and system monitoring to determine and monitor the location, duration, and magnitude of congestion, and to evaluate the effectiveness of implemented actions (US DOT, 1993).

The body of the paper is organized into four sections. The next section describes six categories of measures of transportation system performance. This is followed by a discussion of

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sources of transportation data and methods to collect, assemble, and analyze relevant congestion information. A brief description of analysis and evaluation techniques to support a CMS is presented next. This is followed by summaries of three case studies conducted for the project to test and evaluate the data sources and methods at the city, regional, and state level.

The CMS analytical techniques discussed are currently being used in practice, and can be characterized as being within the state-of-the-art of transportation organizations. Because there is a wide diversity in the congestion and mobility problems throughout the country and considerable variability in available resources, not all of the techniques are appropriate for all situations and all organizations. Many of these methods are comprehensive, however, and should meet present CMS needs under most circumstances.

CMS work plans were submitted to US DOT by state transportation agencies in October 1993. A preliminary review of selected CMS work plans indicates that existing data and analytical methods can provide a reasonable initial foundation for a CMS. At the same time, early experience is indicating that there are situations where existing data and analysis approaches are not sufficient to address the full scope of a desirable CMS.

Methods to Measure Performance

While identifying the various congestion characteristics within a system is a key function of the CMS, identifying the underlying causes of congestion is also important. Additional key functions of a CMS are to evaluate improvement strategies or transportation alternatives and to monitor the effectiveness of implemented actions. These functions require a reliable set of congestion measures and a good set of performance measures. These measures should be strongly related to the goals of the CMS, which should flow from the goals of statewide and metropolitan area transportation plans.

There are a number of properties that are common to desirable CMS performance measures. These include the measurement of person movement and vehicle movement, the determination of delays and the capacity to differentiate between personal travel and the movement of goods and freight. It is also desirable to distinguish incident-based (non-recurring) congestion from recurring congestion. A variety of data collection procedures and analytical methodologies can be used by transportation agencies as the basis for determining CMS performance measures. These measures can be grouped into six general categories: 1) travel time; 2) delay; 3) traffic volume, vehicle classification, and vehicle speed; 4) transit; 5) goods movement, and 6) person movement (Cambridge Systematics, May 1994). Each category of measures is briefly summarized below.

Travel Time

Measurements of travel time are widely used and well-understood indicators of the time it takes to travel from one point to another, including impeded travel. For vehicles (cars, buses, or trucks), travel time is measured from when vehicular travel begins until the trip is completed. Delay occurs when the vehicle is stopped or slowed by traffic controls or congestion. For individuals, travel time is the time it takes to travel from an origin to a destination, and typically includes some amount of walking. Lower travel times or travel times that are within an acceptable norm are generally interpreted as indicators of less congestion. Travel time is considered by many as the best measure of system congestion. When combined with other measures, particularly person and freight movement, it is also an excellent measure of mobility.

Delay

Considered a good measure of congestion intensity, delay can be expressed as the difference between desired or free flow and actual travel time. Delay occurs when the vehicle is stopped or slowed by traffic controls or congestion. Delay for individuals can also include wait time at transit stops and street crossings. Measures of delay do not provide much insight into the specific causes of congestion but can help in the management of non-recurring congestion associated with incidents. In addition, delay measures require general agreement on the definition of free flow travel time.

Traffic Volume, Vehicle Classification and Vehicle Speed

Volume and classification data are used for a variety of purposes. In a CMS, traffic volumes are important inputs to a number of analytical procedures, especially information related to periods of congestion. Vehicle classification describes the composition of traffic, including the percentage of trucks. Speed data, which can be collected with the same traffic monitoring equipment as volume and classification data, can be used to determine travel times and to measure congestion.

Transit

The performance of transit vehicles can be viewed several ways. Existing monitoring programs can be a useful tool for identifying deficiencies in the transportation system. For example, average vehicle speeds or percentage of on-time arrivals collected by transit agencies for scheduling purposes could provide information on congestion levels on arterial streets. Passenger measures can provide some information on the level of mobility being provided by the transportation system.

Goods Movement

The impacts of congestion on the movement of goods can be substantial, affecting truck hours of travel and reliability, which can increase labor, equipment, and operating costs. The availability of transportation data and analytical methods to study truck movements at the regional or state level is limited, however. Nevertheless, because of the potential economic impacts of congestion on goods movement, a CMS should consider the movement of goods within the system to the extent practicable.

Person Movement

Measures of person movement are concerned with the entire trip from origin to destination. Many of the measures are similar to those for vehicles and relate to travel time, travel speed, volume, and delay. The advantage of person movement measures over vehicle measures is that they can be determined across modes and can be a more direct indicator of personal mobility.

Data Sources and Methods

Transportation data can be obtained from a variety of sources. Those cited specifically in the federal regulations relative to CMS are the Traffic Monitoring Systems for Highways, the Highway Performance Monitoring System, and Section 15 transit data. These data sources, including a method to store, analyze, and display data, are described below.

Traffic Monitoring Data

Routinely collected traffic monitoring data can provide the foundation for a congestion management system. Existing data generally are sufficient to calculate a variety of CMS performance measures and can provide the basis for applying other analytical methodologies. Base conditions can be established by using current year count and road inventory data, while historic monitoring data can be examined to determine trends in different variables. Depending upon the resources available to an organization, enhancements can be implemented to improve the utility of traffic monitoring data for the particular objectives of a CMS. These include the locations and time periods where traffic data are collected, the particular information items obtained, and the technology used for data collection.

Highway Performance Monitoring System

The HPMS is an integrated database providing information on the extent, use, condition, performance, and operating characteristics of the nation's highways. It represents an existing database for a stratified sample of roadways that can be used to support a CMS (FHWA, August 1993). These data can be used to calculate a variety of area-wide performance measures, to identify classes of facilities either currently experiencing congestion or likely to experience congestion in the future, and to evaluate candidate improvement projects. A number of analytical methods have been developed by FHWA for use with the HPMS. The HPMS Analytical Process (FHWA, 1987) and the Highway Economic Requirements System (HERS) (FHWA, forthcoming) are software packages that analyze the HPMS data set.

Section 15 Transit Data

One of the most extensive databases on transit operations and finance is found in the federally mandated Section 15 reporting system. Transit operators are required by law to submit data to the Federal Transit Administration (FTA) on a variety of characteristics associated with their service. The data collected in this fashion provide an annual overview of the status of system operations and finance. This information can be used in the CMS (or in coordination with the Public Transportation Management Systems) to support performance measure calculations.

Geographic Information Systems (GIS) and Computerized Databases

GIS and other computer tools that can be used to organize, display, and analyze transportation-related data are emerging as an important form of analytic support for congestion management systems. GIS is proving to be an effective technique for storing and organizing data, helping to integrate disparate sources of information effectively. GIS also is proving to be a powerful analysis methodology; it is more than just graphical display and computer-aided mapping.

Analytical Procedures

In addition to methods of measuring transportation system performance, there are several existing transportation analysis methods that are in use or can be used to support CMS activities. These include computer models for demand forecasting and traffic simulation, sketch planning techniques, and the use of survey data. Also discussed below are general techniques for evaluating implemented strategies.

Travel Demand Model Forecasting Systems

Network-based travel demand forecasting systems have been developed throughout the country on both an urban area and statewide basis. They can be easily incorporated into the set of analytical methodologies supporting a region's congestion management system. These model systems, in many cases, can be immediately used to provide key congestion-related data, forecasts, and performance measures. They have limitations, however, since they were never intended in their original formulation to satisfy the requirements associated with analyzing the full range of potential congestion management strategies (Cambridge Systematics, 1988.)

At the same time, extensive work has been undertaken in recent years and remains underway today directed at overcoming the limitations of travel demand models (Cambridge Systematics and Barton-Aschman Associates, 1994). As a result, today's "state-of-the-practice" travel demand model systems have a much higher level of sensitivity to congestion and mobility issues than do earlier "standard" modeling systems.

Traffic Simulation Modeling

All traffic simulation models use mathematical formulas of detailed traffic flow characteristics to evaluate roadway operations. These models may use a combination of surveyed, projected, or assumed parameters and travel patterns to model the traffic operations on freeway segments or arterial streets. Simulation models generally are divided into two classes of analysis: macroscopic and microscopic, depending on how they treat uncertainty and time. Traffic simulation models are especially helpful in calculating those CMS performance measures involving travel time and delay. Analyses generally are conducted for a specific site or facility, but increasingly, simulation studies are being made on a corridor-wide or small area basis. Current simulation packages are not applicable to large-scale, system-level applications due to limitations on the size of the analyzed network.

Sketch Planning Techniques

Parallel with the enhancements being incorporated into travel demand and simulation methodologies, there are analytical capabilities that are more approximate in nature and require a lower level of resources to apply. Examples include NCHRP 187, NCRHP 255, and the COMSIS TDM model. These "sketch planning analysis techniques," initially were developed to analyze the effectiveness of transportation energy conservation measures, and then subsequently extended to air quality transportation control measures. Today, these sketch planning analysis capabilities are being routinely applied by transportation agencies to examine the full range of transportation demand and congestion management strategies. While they can be independently applied, they also are often used in parallel with traditional four-step travel demand forecasting systems to provide supplemental capabilities that are not directly incorporated in the individual basic models.

Travel Surveys

The four basic types of travel surveys that have traditionally been performed for urban areas are: household travel surveys; on-board transit ridership surveys; commercial vehicle (truck) surveys; and external station surveys. In addition, several other types of surveys have been used in urban areas to collect information on various aspects of travel, including: work place surveys; longitudinal or panel surveys; and stated-preference surveys (Cambridge Systematics, October 1994). These survey techniques are the basic tools used to gather travel information necessary to estimate and calibrate travel models. They can be used in congestion management systems to obtain travel information about the entire trip-making process; this is an important distinction for many person-based performance measures.

Evaluation Methods

An important element of the CMS planning process is the evaluation of implemented strategies. It is very important to be able to measure and document the actual effects of implemented strategies, including how to distinguish between changes resulting from implemented strategies and changes that result from external factors. For example, with respect to ridesharing, the number of program participants may increase due to effective marketing (an implemented strategy) or because of other factors such as gas price changes, a declining economy, or a changing worker population. From a CMS evaluation perspective, it also is necessary to know the prior mode of new rideshare patrons. This helps to determine the degree to which the program is reducing vehicle trips and vehicle miles of travel (VMT).

Case Studies

In order to test and evaluate the data sources and methodologies available to support a CMS, three locations were selected for case studies: Albuquerque, New Mexico; the State of Montana; and Boston, Massachusetts. These sites are broadly representative of the full range of urban areas and states that are implementing CMSs. The use of GIS to support a CMS was demonstrated in Albuquerque. The focus of the Montana testing was on the use of existing traffic monitoring data; specifically, information derived from the HPMS to support a CMS. The purpose of the Boston CMS testing was to demonstrate the integration of data to develop multimodal mobility improvements.

Albuquerque, New Mexico

The goals of the Albuquerque case study were threefold: 1) to evaluate the role that GIS could play in supporting a CMS; 2) to show how a GIS could be used to calculate and display CMS performance measures; and, 3) to investigate the factors and resources needed to implement GIS capabilities within an MPO (Cambridge Systematics and Barton-Aschman, January 1995). The applications examined are based upon the work conducted for the Albuquerque area by the Middle Rio Grande Council of Governments (MRGCOG), the MPO for the three-county area surrounding Albuquerque. This work represents a starting point in the application of a powerful tool for understanding the complex relationships between the spatial, temporal, localized, regional, recurring and non-recurring congestion.

Through an interagency working agreement with the New Mexico State Highway and Transportation Department, the MRGCOG has lead agency responsibility for the development and implementation of the regional CMS for the metropolitan area. MRGCOG planners use the City of Albuquerque's GIS for transportation planning purposes. The elements of planning now done with GIS include:

All mapping, which is done digitally,

Implementation of the regional traffic monitoring program, and

Integration of GIS into the development of the new regional travel forecasting model, including calibration and validation, network development, analysis and thematic mapping.

The objective of the earliest phases of the MRGCOG's CMS work was to define the fundamental elements of the CMS, including, 1) definition of the study area, 2) identification of the CMS network, and 3) identification of performance measures to be considered. The performance measures identified for the region include link-based volume-to-capacity ratios along with level-of-service classifications, to be used as a screening measure to detect links requiring more detailed study. Also included is speed, measured in terms of miles per hour or minutes per mile. With the addition of GIS capabilities, direct measures of accessibility can also be introduced to the CMS. These and other results can all be displayed on GIS-produced maps as an integral element of the annual CMS reporting.

MRGCOG's CMS will require continued investment and enhancement of the regional traffic count program, which has been underway since 1990 (Blewett, 1994). One of the most extensive metropolitan area traffic count programs in the country, the database is now linked to the GIS. This environment offers an interactive graphic interface to view and extract counts, generate turning movement diagrams, and perform various types of analysis in a highly productive and efficient manner.

Several factors have contributed to the success that MRGCOG has had in integrating GIS with transportation planning functions. These include:

Agency acceptance that geographically precise and accurate base maps are not required to support transportation planning functions

The value of having the GIS effort led by transportation planners, who have a unique vision of how GIS applications can solve transportation problems, rather than by computer experts.

The benefits of leveraging available GIS resources by capitalizing on resources already present.

The importance of emphasizing early development of useful databases and applications to produce immediate quantifiable results.

Montana

A primary goal of the Montana case study was to demonstrate the use of existing data such as FHWA's HPMS and analytical capabilities in support of a congestion management system (Cambridge Systematics, January 1995). The inputs used to develop the Montana database were collected from currently available data sources including the Montana Highway Information System (HIS) and the National Planning Association Data Services, Inc. (NPA). Input data related to traffic and roadway conditions were obtained from the HIS and relevant statewide socioeconomic data were obtained from the NPA.

The analysis and results of the Montana case study illustrate the issues, data, and resources required in using traffic monitoring and HPMS databases for the calculation of performance measures in a CMS. Overall, the analyses indicate that databases of traffic monitoring, roadway inventory, and HPMS can be successfully used to support a CMS. This can be accomplished within the resources that are normally available to a state department of transportation. In addition, analytical refinements can be easily introduced, including enhancements to the manner in which traffic forecasts are developed and use of vehicle speed estimation methodologies from the HPMS analytical procedures.

At the same time, the Montana case study also illustrated the relative ease with which data inconsistencies can be easily and inadvertently introduced into an analysis. To avoid this, consistent base year data inputs should be used. The study recommended that future updates of the CMS and HPMS submittals use consistent traffic data and base year definitions. This would provide meaningful comparisons of the analytical methods used to measure transportation system performance.

Boston, Massachusetts

The Boston case study was primarily built upon the results of a multi-year study of transportation characteristics, constraints, and opportunities in Downtown Boston. The study was initiated to improve mobility within Downtown Boston as well as regional access to the city. The main objectives of the case study were to display the use and integration of multiple available sources of data, including non-traditional data, especially those that incorporate measures of goods movement, pedestrians and transit (Cambridge Systematics, February 1995).

The major themes that emerged from the Downtown study are applicable to many US cities. These themes, which form the basis for the strategy development and planning framework of the study, follow:

Most of the downtown streets are local. The majority of streets carry very little vehicular traffic, and can be operated accordingly.

Walking is the primary mode of transportation for downtown circulation. While most trips made <u>within</u> Downtown are on foot, the pedestrian experience is not always positive.

There is intense competition for limited curb and travel space. In some locations, the heavy demand leads to serious congestion problems.

Downtown travel extends beyond peak periods. Almost 70 percent of all trip making to Downtown Boston occurs outside the morning and evening peak hours.

Visitors make a significant portion of all downtown trips. Visitors tend to be less familiar or completely unfamiliar with the transportation system and, when lost, can contribute to congestion problems.

The manner in which each of these themes is addressed has important implications for mobility and congestion on a regional and on a downtown basis. Without proper access to and mobility within the core of Boston, the entire region can be adversely affected.

A variety of transportation data sources were used for the study, including US Census Journey-To-Work data, a comprehensive regional household travel survey, the regional and subarea travel demand models, field counts, interviews of private shippers, mid-day motorists and transit riders, and pedestrians. These described general travel patterns, automobile volumes, transit patronage, truck flows, taxi demands, pedestrian volumes, bicycle patterns, and economic activity.

While not all of the data sources identified for the case study are directly related to congestion, the important finding of this case evaluation is that CMS planning activities in a large urban area can incorporate a wide range of data. In older cities, where the opportunities for expanding roadway capacity are often limited, focusing on other modes of travel and those who travel outside of peak periods are important components of an urban area CMS.

The results of the Downtown Boston case study illustrate the wide variety of area wide data that can be compiled for a large urban area. Much of the data used in the course of developing the Downtown Boston Transportation Plan was either available from traditional sources such as city, regional, or state transportation agencies or collected with traditional methods such as surveys or field counts. Some data were obtained from less traditional sources such as private industry. Compiling data for a study of this scope is relatively uncomplicated. Because Boston is a large urban area with several transportation agencies, more data were available than were ultimately used in the development of the plan.

The case study also illustrates some of the challenges of integrating and applying transportation data in a CMS. This was particularly challenging in terms of incorporating data sources to measure goods movement. Although some data could be obtained, translating those data into measures of performance proved more complex than had been expected. The data were helpful in directing the planning process, however. Although the analysis of the information did not require sophisticated quantitative techniques, strategies that will help to address site-specific congestion problems emerged from the assessment.

The household survey, in conjunction with pedestrian counts and on-board transit surveys, proved especially helpful in addressing the pedestrian and transit patterns in Downtown Boston. These data permitted the study to be truly multimodal and also to address multi-user issues. One of the key considerations for these modes of travel is that most downtown areas have similar concerns with respect to pedestrian movement. Even urban areas with very high automobile mode shares can have high volumes of pedestrians traveling between parking areas and buildings. It is important to integrate the pedestrian experience in the management of vehicles.

Conclusion

Early experience of submitted CMS work plans is suggesting that there is a strong reliance on the use of existing data sources and data collection procedures, consistent with the guidance contained in the DOT regulations, rather than undertaking major new data collection efforts. There are, however, situations where existing data and analysis approaches are not sufficient to address the full scope of a desirable CMS.

In addition, there is a tendency, based on existing professional practices, to continue to look at vehicle movement on individual highway facilities rather than the movement of persons on an area-wide and multimodal basis. The importance of incidents in causing congestion is widely recognized and many areas have implemented incident management systems. Still, the availability of good incident-related data that can be used to help manage the efficient operation of a transportation system is largely lacking. These observations support the conclusion that existing data and analytical methods provide a reasonable initial foundation for a Congestion Management System.

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